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INVESTIGATIONS OF THE OPTICAL
DETECTION OF HYPERFINE RESONANCES
IN ALKALI VAPORS

Report No. 6

Contract No. DA-36-039 SC-87273

DA Project No. 3A99-15-001

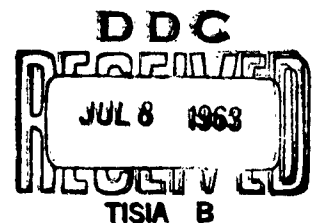
with

U.S. Army Signal Research and
Development Laboratory
Fort Monmouth, New Jersey

6th Quarterly Progress Report
(15 August 1962 to 15 November 1962)

Prepared by
C. O. Alley, Principal Investigator

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Report No. 6

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U.S. Army Signal Research and Development
Laboratory, Fort Monmouth, N.J.

under

Electronic Components Research
Department Technical Guidelines,
28 September 1960
PR & C No. 61 - ELP/R - 4306

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I. PURPOSE

The purpose of this investigation is to conduct experimental and theoretical research on optical pumping techniques for obtaining non-equilibrium population distributions among atomic states, and on optical detection of Zeeman and hyperfine resonances in alkali vapors with particular reference to rubidium gas cell frequency standards. The investigation is a continuation and extension of research performed at Princeton University under Signal Corps contract DA-36-039 SC 70147. Some of the particular areas to be investigated further are the use of coherent pulse techniques for the reduction of line widths and the use of wall coatings for the inhibition of spin relaxation.

II. ABSTRACT

Preliminary experiments on treating cleaved lithium fluoride surfaces with Dri-Film (alkyl chloro silane) vapor to produce a surface that will inhibit spin relaxation were not successful as judged by the failure of water droplets to exhibit a large angle of contact on the treated surface. Other types of Dri-Film or other kinds of surfaces such as Teflon or wax have not yet been tried. It is intended to make direct relaxation measurements for oriented hydrogen atoms rather than rely on the water droplet test, which may not be suitable since LiF is very hygroscopic.

III. PUBLICATIONS, LECTURES, REPORTS, AND CONFERENCES

A lecture was given in September by C. O. Alley to the Rochester section of the Institute of Radio Engineers with the

title "Optical Masers: Principles, Practices, and Potentialities."

A colloquium talk was given in November by C. O. Alley at the Institute of Optics of the University of Rochester on optical pumping and optical masers to acquaint graduate students with current research and future research possibilities.

A graduate course of lectures, Optics 591-592, "Atomic Structure and Quantum Optics" was begun in September by C. O. Alley.

IV. FACTUAL DATA

A. Optical Pumping in Atomic Hydrogen

A first attempt to coat lithium fluoride with Dri-Film SC-02 and SC-77 was not successful. Water droplets did not exhibit a large angle of contact with the coated surface. Also, after the treatment with Dri-Film the transmission of Lyman- α was reduced from 50% to around 20%.

Other types of Dri-Film may work better with LiF but these have not yet been tried. Also, other surfaces than cleaved ones may be more suitable, although these yield the highest transmission for Lyman- α radiation. The hygroscopic nature of LiF may be the chief difficulty in getting a good Dri-Film coating.

Other types of coating such as Teflon should be tried, and it is intended to try this in collaboration with Dr. Robert Vessot of the Bomac Division of Varian Associates who has successfully coated bulbs with Teflon for the hydrogen 21 cm maser. Lithium fluoride blanks so coated will be examined at

Rochester for any change in transmission of Lyman- α radiation.

The best test of a coating is whether it gives a long relaxation time for oriented hydrogen atoms and this will be examined. It may be that the water droplet test is not suitable for lithium fluoride because of its hygroscopic nature.

B. Optical Pumping in Rubidium

The three concentric cylindrical mu-metal shields designed to enclose the solenoid to reduce the effect of external magnetic fields on the homogeneity of the field in the volume occupied by the optical pumping cell have been received.

V. CONCLUSIONS

The failure of the initial attempt to produce a Dri-Film coating on cleaved lithium fluoride surfaces should not be too discouraging. Other types of Dri-Film and surface conditions may be successful. Also other types of surface coating, such as Teflon or very thin wax, give promise of being satisfactory.

VI. PROGRAM FOR NEXT QUARTER

Little activity is planned since no graduate assistants in research will be available. The principal investigator will be occupied largely by research on optical masers, by activities as a government consultant on optical masers, and by preparation of his graduate course in Atomic Structure and Quantum Optics.

Planning for optical pumping experiments using an operating 21 cm hydrogen maser will continue in collaboration with Dr. Robert Vessot of the Bomac Laboratories.

VII. IDENTIFICATION OF TECHNICAL PERSONNEL

		Number of Hours Charged to Contract
C. O. Alley	Principal Investigator Assistant Professor of Optics	80

<p>AD</p> <p>Accession No. _____</p> <p>University of Rochester, Rochester, New York</p> <p>INVESTIGATIONS OF THE OPTICAL DETECTION OF HYPERFINE RESONANCES IN ALKALI VAPORS - C.O. ALLEY</p> <p>Sixth Quarterly Progress Report, 15 Aug 1962 to 15 Nov 1962</p> <p>11 pp. (Contract No. DA-36-039 SC-87273)</p> <p>Unclassified Report</p> <p>Preliminary experiments on treating cleaved lithium fluoride surfaces with Dri-Film (alkyl chloro silane) vapor to produce a surface that will inhibit spin relaxation were not successful as judged by the failure of water droplets to exhibit a large angle of contact on the treated surface. Other types of Dri-Film or other kinds of surfaces such as Teflon or wax have not yet been tried. It is intended to make direct relaxation measurements for oriented hydrogen atoms rather than rely on the water droplet test, which may not be suitable since LIP is very hygroscopic.</p>	<p>Unclassified</p> <p>1. Gas Cell Atomic Frequency Standard Optical Pumping Optical Detection</p> <p>2. Contract DA-36-039 SC-87273</p>
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